

REMARKS

The Examiner's Office Action mailed November 28, 2003, has been received and its contents carefully reviewed. In response to this Office Action, Applicants amended independent claim 1 and independent claim 6 to further distinguish the features and advantages of the present invention. For the reasons set forth in detail below, presently pending claims 1-3, 5-7, and 9 are believed to be in condition for allowance. Reconsideration of this application is respectfully requested.

Claims 1-3, 5-7, and 9 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Akahori et al. in U.S. Patent No. 6,218,299 (hereafter "Akahori") in view of Homma et al. in U.S. Patent No. 5,420,075 (hereafter "Homma"). For the reasons set forth in detail below, it is respectfully requested that the rejection of these claims should be reconsidered and withdrawn.

Amended claim 1 of the present invention recites a method for fabricating a semiconductor device comprising the steps of directly introducing a rare gas including no fluorocarbon into a reactor chamber of a plasma processing apparatus to generate a plasma of the rare gas in the reactor chamber, and densifying a fluorine-containing organic film by directly exposing the fluorine-containing organic film to the plasma thereby heating the fluorine-containing organic film in the same reactor chamber. Since the fluorine-containing organic film is exposed to the plasma in the same reactor chamber after the step of depositing the fluorine-containing organic film, the effect of reducing the required process step and preventing the attachment of particles during transportation can be achieved.

The Akahori reference, in contrast, appears to disclose forming a metal interconnection, that is, a metal wiring layer, on a substrate, and depositing an interlayer dielectric film composed of a fluorine-containing organic film between the metal interconnections using a material gas containing gas C_nF_m , where m and n are integers, as a main component. However, the Akahori reference fails to disclose directly introducing a rare gas including no fluorocarbon into a reactor chamber, in which a semiconductor substrate is

provided, to generate a plasma of the rare gas in the reactor chamber, and densifying the fluorine-containing organic film by directly exposing the fluorine-containing organic film to the plasma thereby heating the fluorine-containing organic film in the same reactor chamber.

The Examiner asserts that the Akahori reference substantially discloses densifying the fluorine-containing organic film by Ar plasma in column 7, lines 19-21. Applicants respectfully disagree with the Examiner's characterization of the Akahori reference. In fact, the Akahori reference completely fails to disclose the limitations of the above claims. For example, in column 6, line 51 to column 7, line 32 and in Fig. 5 of the Akahori reference, in the CF film depositing step, the wafer 10 is provided in the film-forming chamber 22. In addition, a $C_4F_8 + C_2H_4$ gas for film forming is directly introduced into the film-forming chamber 22 while at the same time, an Ar gas is directly introduced into the plasma-creating chamber 21, which is different from the chamber in which the wafer 10 is provided. The Argon gas and the wafer are in different chambers. Subsequently, a 2.45GHz microwave is introduced into the plasma-creating chamber 21 from the radiofrequency generator 24, and an electron cyclotron resonance (ECR) is generated by the electrical field E and the magnetic field H, thereby making the Ar gas into a plasma, and highly densified.

The $C_4F_8 + C_2H_4$ gas in the film-forming chamber 22 in which the wafer 10 is provided forms active species, and thereby deposits a CF film on the wafer 10. Hence, according to the Akahori reference, Ar gas is introduced into the plasma-creating chamber 21 in which the wafer 10 is not provided to generate a plasma, while no Ar gas is directly introduced into the film-forming chamber 22 in which the wafer 10 is provided, and no Ar plasma is being generated therein.

In contrast, Fig. 1 of the present invention shows the rare gas is directly introduced into the reactor chamber 10 in which the semiconductor substrate 12 is provided to generate the plasma within the reactor chamber. Moreover, the fluorine-containing organic film is densified by directly exposing the fluorine-containing organic film to the plasma thereby

heating the fluorine-containing organic film. Hence, the Akahori reference describes a method that is completely different from the present invention.

Further, in the Akahori reference, since the Ar plasma is generated in the plasma-creating chamber 21 (see Fig. 5) separated from the chamber 22 in which the wafer 10 is provided, the wafer 10 is separated from the Ar plasma. Accordingly, since the wafer 10 is not directly exposed to the Ar plasma, it should be recognized that the wafer 10 is substantially not affected by the heating effect of the Ar plasma. Hence, the CF film forming method of Akahori is not a method for densifying the CF film.

Even upon further examination, the Akahori reference fails to disclose densifying the CF film by exposing the CF film to the Ar plasma and thereby heating the CF film. The Examiner asserts that the Akahori reference teaches densifying the fluorine-containing organic film by Ar plasma and refers to column 7, lines 19-21 as support for this assertion. Applicants respectfully disagree with the Examiner's characterization of the Akahori reference. The plasma referred to in the Akahori reference is the Ar gas plasma, *not* the film that is highly densified (see Akahori '299 patent, col. 7, lines 8-21). Akahori discloses, "[T]hat a stabilized plasma can be created by the use of Ar gas" (see col. 7, lines 19-21). Accordingly, in Akahori, an electron cyclotron resonance (ECR) plasma apparatus, which can generate high-density plasma, is used to generate the plasma (see col. 6, lines 17-27 and 28-34). As described above, the plasma apparatus shown in the Akahori reference is an ECR plasma apparatus, and "an electron cyclotron resonance (ECR) is generated by the electrical field E and the magnetic field H, thereby making the Ar gas into a plasma, and highly densified." It is evident to one of ordinary skill in the art that simply because the Ar plasma is highly densified, it does not imply that the CF film is also highly densified. It is also generally known to one skilled in the art that an ECR plasma apparatus is an apparatus that can generate highly densified plasma. The densification of the CF film, however, is not disclosed. Therefore, the Akahori reference completely fails to disclose densifying the CF

film by directly exposing the CF film to the (Ar) plasma of the rare gas thereby heating the CF film as recited in amended independent claim 1.

The cited Homma reference fails to cure this deficiency. The Homma reference appears to simply disclose forming a pattern of metal wirings by using a photo resist mask and etching, and forming an insulating film between the wirings. Homma fails to disclose the step of densifying the fluorine-containing organic film by directly exposing the fluorine-containing organic film to the plasma thereby heating the fluorine-containing organic film in the same reactor chamber.

As described above, since both the Akahori reference and the Homma reference fail to disclose generating plasma of the rare gas in the reactor chamber in which the semiconductor substrate is provided and densifying the fluorine-containing organic film by directly exposing the fluorine-containing organic film to the plasma thereby heating the fluorine-containing organic film in the reactor chamber, the combination of the Homma reference with the Akahori reference does not render amended claim 1 of the present invention obvious. Applicants respectfully submit that the present invention is patentable over the combination of Akahori and Homma references and request reconsideration of claim 1 and withdrawal of the rejection under 35 U.S.C. § 103.

Likewise, Applicants respectfully request that the rejection under 35 U.S.C. § 103(a) of dependent claims 2, 3 and 5, which depend upon amended independent claim 1, also be reconsidered and withdrawn for similar reasons set forth above with independent claim 1.

Amended claim 6 of the present invention recites a method for fabricating a semiconductor device that includes directly introducing a rare gas including no fluorocarbon into the reactor chamber of a plasma processing apparatus to generate a plasma of the rare gas in the reactor chamber, and densifying a fluorine-containing organic film by directly exposing the fluorine-containing organic film to the plasma thereby heating the fluorine-containing organic film in the same reactor chamber.

As discussed above with regard to amended independent claim 1, both the Akahori reference and the Homma reference fail to disclose generating plasma of the rare gas in the reactor chamber in which the semiconductor substrate is provided and densifying the fluorine-containing organic film by directly exposing the fluorine-containing organic film to the plasma thereby heating the fluorine-containing organic film in the reactor chamber. Therefore, the combination of the Homma reference and the Akahori reference does not render amended claim 6 of the present invention obvious. Applicants respectfully submit that the present invention is patentable over the combination of Akahori and Homma references for at least the same reasons as outlined above with regard to amended independent claim 1. Applicants respectfully request reconsideration of claim 6 and withdrawal of the rejection under 35 U.S.C. § 103.

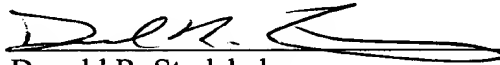
Similarly, Applicants respectfully request that the rejection under 35 U.S.C. § 103(a) of dependent claims 7 and 9, which depend upon amended independent claim 6, also be reconsidered and withdrawn.

CONCLUSION

Therefore, in view of the foregoing Amendments to independent claims 1 and 6, it is respectfully requested that the rejections of record be reconsidered in view of the Amendment and be withdrawn by the Examiner. It is further requested that claims 1-3, 5-7, and 9 thus be allowed and that the application be passed to issue.

Should the Examiner believe a conference would be of benefit in expediting the prosecution of the instant application, he is hereby invited to telephone counsel to arrange such a conference.

Respectfully submitted,



Donald R. Studebaker
Reg. No. 32,815

Nixon Peabody LLP
401 Ninth Street, NW
Suite 900
Washington, DC 20004
(202) 585-8234